JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 10 JUNE 19, 1920 NO. 12

SCIENTIFIC RESEARCH.—*The economic importance of the scientific work of the Government.*[1] E. B. ROSA, Bureau of Standards.

SCIENCE IN THE WAR

1. The Great War was based very largely on science and engineering. During the twenty-five years preceding the outbreak of the war the enemy had developed science and the practical applications of science in a wonderful way. He had fostered the industries, developed shipping and foreign trade, and promoted scientific research and education until the German nation stood in the forefront of the nations of the earth. With a complete misunderstanding of race psychology and an utter lack of appreciation of moral values, the enemy had prepared for a sudden attack with crushing force when a favorable occasion should arise. When the blow fell the allied nations were unprepared, not only for lack of armies and munitions but for lack of industrial equipment, transportation facilities and scientific development. Holding the enemy at bay under fearful odds while they built up their armies and their industries, the allied and associated powers utilized all the resources of science and engineering and a vast amount of accumulated treasure to make good their initial deficiencies and gain strength enough to wear out and overcome the enemy. In this titanic struggle scientists, engineers and captains of industry were mobilized by

[1] A lecture given before the Washington Academy of Sciences on May 20, 1920.

the tens of thousands, and men and women in the industries by the tens of millions, in order that the soldiers and sailors in the armies and the fleets might be adequately supplied with food, munitions and equipment. The wonderful achievements of science under the pressure of necessity demonstrated the economic possibilities of scientific research. This demonstration was not altogether new, but the war brought it home more forcefully, and at its close one felt that never again would anybody question the importance and economic value of scientific investigation.

NECESSITY FOR INCREASED PRODUCTION

2. The war was conducted on such a gigantic scale that the world's supply of raw and manufactured materials was largely exhausted. The increased demand thus caused for labor and commodities, together with the inflation of currency and credit, and in many cases the reduced efficiency of labor have raised prices beyond all precedent. Hardship and suffering have come to hundreds of millions of people throughout the world and political and economic confusion generally has resulted.

The cost of living during the war increased considerably, but wages were so high that many classes of workers were more prosperous than ever. The government directed the channels of trade and controlled the supplies of materials with much success, and prices in most cases were kept within bounds. With the end of the war came an end of governmental control, and also, with many, an end of economy and thrift, and for these and other reasons, prices have been mounting steadily ever since. Increased costs led to industrial unrest, strikes, high wages and further rise in prices. Profiteering has been denounced in the press and sought out by the government, but the average of prices continues to rise. It is generally agreed that in order to bring down prices it will be necessary (1) to contract currency and credit, (2) to economize in the use of necessities and luxuries, and (3) to utilize raw materials and labor more effectively and expand the production of commodities. The first remedy must

be worked out by financiers and economists. The second might be accomplished by a nation-wide campaign for thrift and economy; and the third would be greatly aided by cooperative study and scientific and technical research on a comprehensive scale.

THE GOVERNMENT AND INCREASED EFFICIENCY

3. There is a shortage of labor in the country, and a tendency to shorten rather than to lengthen the hours of labor. If, therefore, production is to be increased without increased labor, it is necessary to increase the productivity of labor. To economize in the use of staple commodities and luxuries, to reduce the waste of raw materials, to make use of cheaper materials, to increase the efficiency of men, of machines and of processes, on a nation-wide scale and at an early date will call for intelligent and energetic effort, comparable in difficulty and importance with the task before the country in 1917 when we entered the World War. It is not merely in order to reduce the cost of living to those millions whose incomes have not increased in proportion to the rise in prices, and who in many cases are suffering hardship and distress; but it is to allay industrial discontent and forestall economic and political disturbance or even disaster. The confusion and inequity that have resulted from the rise of prices threaten the stability of society. The governments of the world are face to face with the problem of improving conditions and allaying discontent. To hold that governments cannot or should not deal constructively with the most serious problems of society, but that such matters should be left to chance, without organized effort or leadership, is not a satisfactory position to take after the successful experience with government leadership in the war. The old idea that the less government we have the better, no longer applies, if it ever did. Society is made up in part of a multitude of groups, some of which are highly organized, and many are seeking the advantage of the group rather than of society as a whole. The government represents the interests of society as a whole, and its problems and responsibilities have increased enormously in recent years.

THREE KINDS OF GOVERNMENTAL FUNCTIONS

4. Henry C. Adams, in his treatise on the Science of Finance, classifies governmental functions into three groups, namely, (*a*) The protective functions of government, (*b*) the commercial functions of government, and (*c*) the developmental functions of government.

(*a*) The protective functions of government are divided into three principal classes: (1) Protection against invasion or encroachment from without is provided by the army and navy, and this has always been an important and relatively expensive department of a national government. (2) Protection of life, property and reputation, which is accomplished through police, fire departments and the courts. (3) Protection against the spread of disease, either physical or social. As crime is looked upon as a phase of social disease, this will include prisons, asylums, sanitary provision, public charities, etc.

(*b*) The commercial functions of government include those which render a service for which payment is made by the individuals served, and are in general self-supporting. They address themselves primarily to the personal needs of the citizen rather than to the social needs of the state, and are performed by the state because it can render the service better or cheaper than private agencies. Examples are the post office, and in some cases railways, canals, telegraphs and other public utilities, patents and insurance.

(*c*) The developmental functions of government "are such as spring from a desire on the part of society to attain higher forms of social life." Society is not merely a collection of individuals, but is a conscious organism and the interests of society require collective action in developing itself. This includes: (1) Public education, (2) public recreation, (3) providing those legal and administrative conditions in which private business will be conducted in a just and equitable manner, (4) public investigation and control of public utilities, (5) developing the resources and wealth of the state, which includes scientific and industrial research.

DEVELOPMENTAL FUNCTIONS OF THE FEDERAL GOVERNMENT

5. These three classes of functions are exercised to some extent by municipal and state governments as well as the federal government. The powers of the federal government were delegated to it by the states, and were intended to be those required for the exercise of sovereignty by the nation in its relation with other nations, the maintenance of a national army and navy, the provision of a national currency, a common postal system, a uniform system of weights and measures (although this was not carried out as intended), the regulation of interstate commerce, etc.

In the early years of our history, society was relatively simple, communication and travel were infrequent, and each community was comparatively independent. Hence local governments were, in many respects, more important than national. With the developments in transportation and communication which have resulted from steam and electricity, the forty-eight states have come very close together, commerce and industry have much in common everywhere, uniformity of practice and uniformly good practice are generally desired, and it has been a problem how to avoid confusion of administration and industrial practice when there were so many legislatures and administrative bodies acting independently of each other. This has been partly accomplished by the cooperation of federal agencies with state bodies, leaving the legal authority with the states.

Many protective and developmental functions have long been exercised by the federal government because they were of common interest to all the people, and they could be performed more effectively and more economically by the federal government than by the several states, and there was no practicable way of getting all the states to work in harmony on a common program. The people who support the federal government are the same people who support the forty-eight state governments, and hence the plan of acting together through the federal government in performing functions of interest to all is not only economical and efficient but logical and just.

SCIENTIFIC RESEARCH A LUXURY OR A NECESSITY?

6. For many years the revenues of the federal government were ample and easily obtained. Taxation was indirect and not felt and many of the developmental functions of the government were exercised with little question or objection. The Great War involved enormous expenditures and increased the fixed charges due to the public debt and other war obligations to several times the former budget. The result is that expenditures for education, scientific research and development work are severely scrutinized, and the question is raised as to whether we can afford to carry on such work on a generous scale. It is, of course, proper that every item in the national budget be closely scrutinized, and that nothing be passed which cannot justify itself. It is desirable, therefore, to inquire whether scientific research as carried on by the federal government is a luxury or a necessity; whether it is something to be enjoyed when taxes are light and curtailed when taxes are heavy; or whether it is creative and wealth-producing, and therefore to be increased and developed when expenses are abnormally large and a heavy debt must be liquidated. The question is, in short, whether scientific and industrial research and education are like good seed and fertilizer to a farmer, which are essential to the best success; or whether they are as luxuries to the rich which consume but do not produce, and which should be curtailed when necessary expenses increase.

THE NATIONAL BUDGET

7. In order to discuss the question concretely and with reference to actual conditions, let us examine the national budget as it stands for the current fiscal year, with appropriations amounting to a total of $5,686,005,706, as given in the regular supply bills and three deficiency bills prior to May 1, 1920. For convenience, we may divide it into six parts as follows:

GROUP I.	Obligations arising from recent and previous wars, including interest on the public debt, pensions, war risk insurance, rehabilitation and care of soldiers, deficit in the operation of railways, expenditures of the Shipping Board, European food relief and the bonus to government employees to partially cover the increased cost of living due to the war, a total of.....	$3,855,482,586
GROUP II.	War and Navy Departments, expenses somewhat above a permanent peace-time basis.....	1,424,138,677
GROUP III.	Primary governmental functions, including Congress, President and White House staff, courts and penal establishments, departments of Justice, State, Treasury, Interior, Commerce, Labor, Interstate Commerce and other commissions, one-half the District of Columbia, including all the necessary functions of government other than defense, except the commercial activities of Group V and the research, education and developmental work of Group VI.....	181,087,225
GROUP IV.	Public works, including rivers and harbors, public buildings, reclamation service, post roads, national parks and railway in Alaska.....	168,203,557
GROUP V.	Commercial or self-supporting activities, including the Post Office, Patent Office, Land Office, Panama Canal, and Housing Corporation, which taken together earn their expenses....	
GROUP VI.	Research, educational and developmental, including the wide range of work of the Agricultural Department, Geological Survey, Bureau of Mines, Coast and Geodetic Survey, Bureau of Standards, Bureau of Fisheries, Bureau of Foreign and Domestic Commerce, Bureau of Labor Statistics, Women's and Children's Bureaus, Vocational Education, Colleges for Agriculture and Mechanic Arts, Library of Congress, Smithsonian Institution and the Public Health Service..	57,093,661
	Total.....	$5,686,005,706

ONE PER CENT FOR RESEARCH, EDUCATION AND DEVELOPMENTAL WORK[1]

8. The first two groups together amount to 92.8 per cent of the total; public works amount to 3 per cent, primary govern-

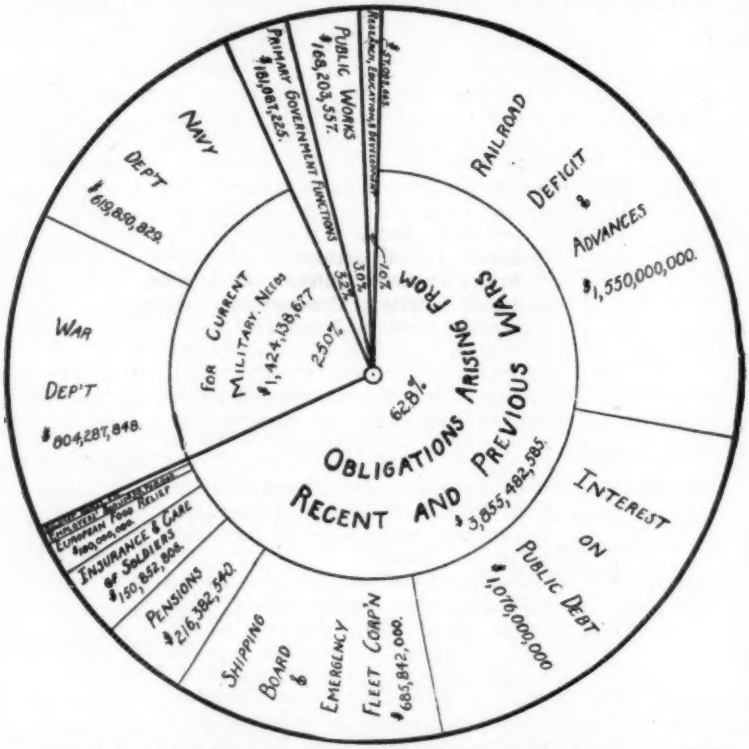

Fig. 1.—Distribution of government appropriations for the fiscal year 1920 (July 1, 1919 to June 30, 1920, inclusive). See table on page 380 and summary on page 382.

[1] For the next fiscal year, the appropriations needed for the railroads and Shipping Board, and for the Army and Navy, will be very much less than for the current fiscal year. The Treasury Department, therefore, expects to be able to make a very substantial reduction in the floating debt, now amounting to nearly three billions of dollars. The appropriations for Group VI for the next fiscal year are substantially the same as for this year. The ratio of Group VI to the total will, therefore, be substantially the same as at present (namely, one per cent), if we include, as we should, the payments on the floating debt and sinking fund in Group I, and if the total revenues for next year are approximately the same as for this year.

mental functions 3.2 per cent, and research, education and developmental work 1 per cent. The population of the country being about 110,000,000, the total budget is about fifty dollars per year per capita, of which fifty cents per year per capita is expended for the wide range of research, education and development work included in Group VI. That is, of the fifty dollars per year per capita collected for all purposes, a dollar and a half per year per capita is spent for what is here called the primary functions of government; nearly as much more is put into public works, and fifty cents per year is put back into research, educational and developmental work, to promote scientific research, to increase production and efficiency, to develop wealth, to promote the public health, and to conserve our natural resources. This is a very small part of the total, hardly enough to be regarded as a burden on the nation. Indeed, one is led to wonder whether the total burden of taxation would not be lighter if the expenditure for scientific and developmental work were increased; if, for example, it were one dollar per year per capita instead of fifty cents. In other words, if $110,000,000 were expended annually for this creative and productive work, would it not be easier to collect the five and a half billions for other purposes? To answer this question intelligently, it will be well to look a little closer into how the fifty cents per capita is expended and what is accomplished thereby.

WORK OF THE AGRICULTURAL DEPARTMENT

9. Nearly two-thirds of all the expenditures made under Group VI are for the work of the Agricultural Department. Agriculture is the most important industry of the nation. Agricultural and animal products amount possibly to twenty-five billions of dollars per year. Food has risen in price in recent years along with other products, partly because of higher wages and higher cost of machinery and supplies used by farmers, but largely because the urban population has increased faster than the rural and the demand for food products has increased faster than the supply. It is of prime importance to city dwellers that food products be produced in greater quantity, and this requires

an increased efficiency or an increased rural population, or both. The Agricultural Department carries on a wide range of educa-

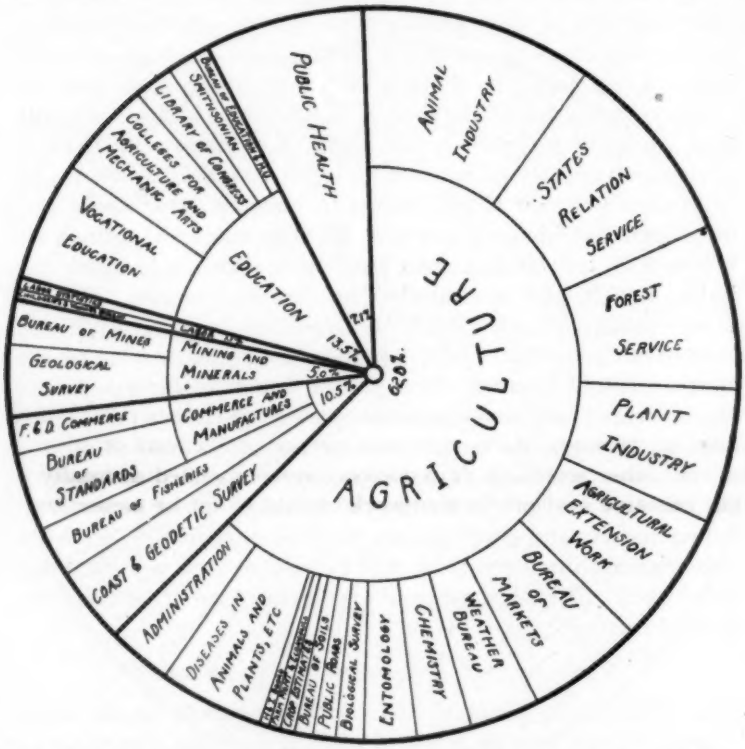

Fig. 2.—Distribution of appropriations for research, education and development, Group VI. See summary on page 381.

tional and experimental work in order to increase the production of farm products and to promote the interest of the farmer in his work, as well as to make life on the farm and in rural communities more attractive. This not only benefits the farmer but tends to keep food prices within reason for city dwellers. It is therefore serving all the people, and its work was never so much needed as at the present time. It is spending about $1.50 for

every $1,000 of value of agricultural and animal products, and without doubt the results achieved pay many times the cost of the work. The work of the Forest Service is nearly self-supporting, and might have been put into Group V. This year, owing to unusual forest fires, its deficit is larger than usual. Ultimately it will be more than self-supporting. The work of the various bureaus is of great importance and absorbing interest, but time does not permit even a brief description.

THE GEOLOGICAL SURVEY AND THE BUREAU OF MINES

10. The Geological Survey and the Bureau of Mines are concerned with the mineral industries of the country: coal, iron, copper and the other industrial and precious metals, oil, gas and the water supply and the topography of the land. Our country is rich in these natural resources and we are spending them in prodigal fashion. It is the business of these two bureaus to survey and map the distribution of metals and minerals; to look for new sources of supply; to gather statistics and to increase safety and efficiency in the mining and metallurgical industries; and to consider what can be done to conserve these natural resources which, unlike the products of agriculture, are not reproduced in annual cycles, but when once used can never be replaced. In addition, topographic and water power surveys are made and mapped. The products of the mineral industries of the country amount possibly to six billions of dollars per year. They are indispensable to our manufactures, and a most important part of our national wealth. If these two bureaus were to spend in this important work of research and development, an amount equal to one dollar in a thousand of the annual value of mineral products, it would amount possibly to six millions of dollars per year, which is more than double present expenditures. Can there be any doubt that such a sum expended in the interest of the public that pays the entire cost, and must bear the burdens of any inefficiency that exists in the industries, would be amply repaid? For example, millions of dollars are worse than wasted every year in accidents that could be prevented. Mining is one of the most hazardous of industries. The Bureau of Mines

has done a great deal of valuable work, both in research and education, to make mining safer; but there is need for a great deal more than it has been able to do. The results of such work are available in all the states where mining is carried on. It can generally be done better, and far more economically, than if done by the states unaided by the federal government. These two bureaus are doing a work of great economic importance at a cost to the people of this country of three cents per capita per year. If it were doubled the burden would be only slightly increased, but the service rendered in the increased efficiency of production and fewer accidents and more intelligent use of our natural resources would be very considerable. This is a splendid example of the economic and social value of cooperation of all the people through the agency of the federal government in doing efficiently what is needed by all.

THE BUREAUS OF STANDARDS AND OF FOREIGN AND DOMESTIC COMMERCE

11. The Bureau of Standards develops and maintains the standards of length, mass, volume, temperature, electrical and optical measurements, prepares standard chemicals and does many other kinds of fundamental work; it does testing for the government and the public, and it carries out scientific and industrial researches to develop the industries. A very large amount of work is done for the army, navy and other departments and for state institutions, so that not more than one-half of its total expenditures can properly be considered as done for the development of the industries. Excluding food products, tobacco and liquors, the annual value of manufactured products in this country, over and above the value of the raw materials entering into them, is possibly $12,000,000,000. The Bureau of Standards spends this year a sum not more than 15 cents per $1,000 of manufactured products in all its work, and as stated above, not more than one-half of it is for the purpose of developing these manufactures. If this sum could be considerably increased, it would enable a much larger amount of work to be done and the work could be carried on more efficiently. I shall give examples

presently of such work, and you may judge whether it would be profitable.

While the Bureau of Standards maintains and makes available the standards of measurement, of quality, of performance, and of practice, for commerce and the industries, and engages in research to develop the industries, the Bureau of Foreign and Domestic Commerce is concerned with the development of commerce and our export trade. The importance of foreign trade to a great nation, and the opportunity and duty of the government in fostering that trade in all legitimate ways, need no emphasis on this occasion. In view of the position of America as a world power, and in view of the general desire that our foreign commerce may be not only profitably but creditably conducted, it would seem that this function of the government would be developed and strengthened.

THE COAST SURVEY AND THE BUREAU OF FISHERIES

12. The Coast and Geodetic Survey is one of the oldest branches of the government doing scientific and technical work, and until the establishment of the Bureau of Standards, kept the standards and did the testing of weights and measures. It is charged with the survey of the coasts and rivers to the head of ship navigation, and the publication of charts, giving the results of base measurements, triangulation, topographic and hydrographic surveys, deep sea soundings, temperature, magnetic observations, gravity research, determination of heights, latitude, longitude, and reference points for state surveys. The work is very fundamental and important and has been done with a high order of precision and thoroughness, and with marked credit to the government.

The object of the Bureau of Fisheries is the stimulation of the production and consumption of fish as an important source of food. To stimulate production, scientific research on the habits and propagation of fish is carried on. The breeding of fish and their distribution into lakes and streams is done on a large scale. In all of this work, but particularly in connection with the propagation of fish and the protection of fish against lawlessness,

the Bureau cooperates with the various states. The responsibility of the government for work of this kind is obvious, and there can be no doubt as to its being profitable.

THE BUREAU OF LABOR STATISTICS, THE WOMAN IN INDUSTRY SERVICE AND THE CHILDREN'S BUREAU

13. The Bureau of Labor Statistics gathers the statistics of wages in the various industries and the cost of living, and publishes much valuable material of interest to labor and capital. The prosperity and happiness of all the people depend to a considerable extent upon industrial peace and freedom from strikes and disorder. Industrial peace and contentment require justice and fair dealing between employers and employed. In order that both may know what is just and fair, statistical information as to wages and changes in prices and the cost of living is essential. It is probable that the greatest obstacle to a good understanding between employers and employed is lack of information. Suspicion and prejudice often give way to sympathy and understanding when full information, including information about what others are doing, is made available. The good results achieved by generous treatment of labor should be put before all employers, and if the government would spend more on research and education in this important field, might it not save much that is now spent in other directions? And might not the public be saved much both in expense and inconvenience that results from industrial warfare? This subject is of such tremendous and far-reaching importance that one is led to ask whether the government is doing as much as it should in this connection.

The work of the Children's Bureau and the Woman in Industry service is relatively new, but of great importance. Women are employed in the industries more than ever before, and the high wages and shortage of labor increases the pressure for the work of children. In the interest of the state, apart from considerations of humanity, women and children should be protected in the industries; and the work of these two bureaus is therefore of fundamental importance. It seems likely that it will grow rapidly in magnitude and occupy a larger place in the public's thought.

EDUCATIONAL WORK

14. The Bureau of Education collects and disseminates information concerning educational matters. The federal government has never taken a very active part in the educational work of the country. Whereas cities spend an average of $6 per year per capita for education and the states and private agencies about $3 per year per capita, the federal government spends only 6 cents per capita per year, including the sums expended in vocational education and assistance granted to colleges of agriculture and mechanic arts. Common schools and high schools are maintained by towns and municipalities, with some aid from the state. Normal and secondary schools, colleges and universities are maintained by the states and private agencies. Indeed private schools and privately endowed colleges and universities constitute a very important part of our educational system. The federal government, on the other hand, has no national university, and spends no money in the District of Columbia on higher education, except for Howard University for colored students. The Bureau of Education has for many years been doing a valuable work in keeping a record of the educational work of the country. Its support might well be greatly augmented, its scope broadened, and its activities and responsibilities correspondingly increased. We believe thoroughly in this country in popular education. We believe that the welfare of the state demands an intelligent electorate, and that material prosperity goes with education. The war revealed an unsuspected percentage of illiteracy in the men examined for military service. A million men in the draft could not read and write. The federal government might well take greater responsibility in matters of education and cooperate more actively with the states, setting standards for educational work and giving direction and encouragement where they are needed. A Department of Education with a cabinet member at the head, has more than once been proposed, and is even now being discussed.

Better facilities for higher education in the District of Columbia would be of great value to thousands of federal employees, as

well as to other residents of Washington. The desire of federal employees for educational advancement should be encouraged and the needed facilities supplied, partly for their own sake and partly because they would thereby be enabled to render better service to the government. Washington is the proud capital of the richest nation on earth, and yet there are few cities in America and few capitals anywhere in the world where so little is done for higher education.

Recently, the Federal Board for Vocational Education has been established, and a substantial sum placed at its disposal. The need for vocational training was emphasized by the results of tests made in the army. Of men claiming expert knowledge of the skilled trades, only six in a hundred were found to be really expert. The Board assists the states financially and otherwise in developing and maintaining a system of vocational training. Such work is greatly needed as industry itself fails to supply the training necessary.

For many years the government has been cooperating with the states by paying a certain sum of money each year to one college in each state for the teaching of agriculture and mechanic arts. This was provided for under the Morrill act, and these payments now amount to $2,500,000 per year. In most cases these sums are a very substantial help to the institutions receiving them, and undoubtedly do a very great deal of good in the aggregate.

An English journal, commenting on the increased sums allotted in the English budget for next year to scientific and industrial research, has this to say: "Education and the financing of that education are important subjects. Indeed, we do not hesitate to say that upon the right method of instruction being followed depends very largely the future prosperity of the nation."

THE LIBRARY OF CONGRESS AND THE SMITHSONIAN INSTITUTION

15. The Library of Congress is a great national institution, corresponding to the British Museum and the Bibliotheque Nationale. It is properly grouped with the educational institutions of the government, and it is an institution of which all

Americans are proud. It is a great library, housed in a beautiful building, useful to thousands, enjoyed by hundreds of thousands. The country approves a generous policy toward this activity of the government, devoted as it is to art and education.

The Smithsonian Institution and the National Museum are national institutions devoted to science, art, and natural history. The Smithsonian Institution has a private endowment, but the greater portion of its funds comes from the government. It carries out scientific researches in the physical and natural sciences and has extremely valuable collections in its museums and art galleries. The government has not done as much in promoting art and collecting works of art as have many other governments, and it is to be hoped that much may be done in the future to compensate for past neglect of these matters.

THE PUBLIC HEALTH SERVICE

16. The Public Health Service is one of the most important of the agencies doing work of research and education. It maintains supervision over incoming vessels to prevent the introduction of diseases; to prevent the spread of diseases between the states it makes inspections and cooperates with the state departments of health; statistics of diseases are collected and interpreted, and scientific research is carried out to develop methods of preventing the spread of disease.

The Service has recently formulated a comprehensive health program to be carried out on a nation-wide scale by the active cooperation of federal, state, and local authorities and voluntary organizations. That these needs are urgent is shown by the fact that more than one-third of all men examined under the draft during the war were rejected for physical defects and diseases. The Surgeon General states that in large measure these defects and diseases could have been prevented had proper attention been given to them, especially in childhood. This unsatisfactory condition of the public health shows the need of greater attention on the part of the federal government, and more systematic cooperation between local and national agencies.

This systematic cooperation is obtained by the federal aid extension principle, as in the construction of good roads, and agricultural education.

A large amount of most valuable medical, statistical, and research work is carried on by the Public Health Service, which has been greatly developed in recent years. The opportunities presented in this work for growth and increased usefulness are almost boundless. In addition to its work in connection with the public health, a large amount of work is done in the care and rehabilitation of sick and wounded soldiers.

The foregoing brief outline of the activities of the various government agencies included in Group VI gives a very incomplete statement of the research and educational work done by the government. It is, however, intended to convey some idea of the wide range and important character of this work, and its great possibilities for development if more adequate provision could be made for its support. A portion of the work of the Bureau of Chemistry, the Bureau of Standards, the Coast and Geodetic Survey and other bureaus of Group VI would have been included in Group III if the work of the bureaus had been split up and the classification had been more detailed and exact. On the other hand, a portion of the work of the Naval Observatory, the Bureau of the Census, and other bureaus in other groups is scientific and educational. It is not possible to make a simple classification that is perfectly exact, but it is believed that the one given is sufficiently exact for the purpose. The Public Works group has value in economic development, but it is not research and educational, and is quite different from most of Group VI. It is now proposed to speak more in detail of one important kind of scientific research, namely, that designed to develop the industries of the country. This work is done primarily in the public interest, although it is generally helpful and beneficial to the individual owners.

COOPERATION BY THE GOVERNMENT IN INDUSTRIAL RESEARCH AND STANDARDIZATION

17. The success of industrial research work by the government

has been amply demonstrated. That government laboratories have done scientific and technical work of the highest quality, and done it efficiently and acceptably to the public, is generally admitted. Their efficiency will not suffer in comparison with that of commercial organizations. It is doubtful if any commercial organization could approach the performance of government laboratories if the board of directors had maintained an inflexible and inadequate salary scale for all the more responsible technical and administrative positions as the government has done.

Scientists and engineers in the service of the government appreciate the opportunity of carrying on researches and constructing public works in the public interest, and of being able to make investigations and publish results unfettered by commercial considerations. In consideration of these advantages, many are willing to remain in the government service at less salary than could be earned elsewhere. Until recently the government has been able to retain its able men on the average nearly as well as the colleges and the industries. During the past few years, however, circumstances in this respect have changed. While the cost of living has nearly or quite doubled, and salaries in the industries and in many of the colleges have been considerably increased, government salaries have increased very little and in the higher grades not at all. The result is that in many cases men cannot support their families, and are obliged to seek employment (or accept employment offered or urged upon them) at a living salary. In many cases men who are making a splendid success and have regarded the government service as their career, leave their positions from necessity and with the greatest reluctance. Often these positions cannot be filled and the work suffers or ceases altogether. It is believed, however, that this condition will not continue indefinitely. A readjustment of the salary scale must be made if the government is to have the services of a competent and permanent staff to conduct its scientific and administrative work. In view of the splendid success achieved in the past, it does not seem possible that this essential part of an effective government will be allowed

to disintegrate and go to pieces. Industrial research conducted by the government with the active cooperation of the industries, and in some cases of the states, may be made even more important and successful in the future than in the past; for it is needed now more than ever, and is appreciated as never before.

In order to give a more concrete idea of the practical usefulness and economic importance of research and standardization, a number of special cases will be cited in the field of the Bureau of Standards. These cases are chosen partly because I am especially familiar with the work of this Bureau, and partly because there appears to be at this time especial need of the kind of constructive scientific research in the manufacturing industries which it is one of the functions of this Bureau to carry on. Equally striking examples could be cited in Agriculture or Mines or other lines of government research.

STANDARDIZATION AND RESEARCH IN THE BUILDING INDUSTRIES

18. For several years recently the building of homes has been almost suspended, and now there is a scarcity of houses in many cities. Meantime the cost of building has increased enormously, due to the greatly increased cost of labor and materials. In consequence real estate and rents have risen beyond all precedent. There never was a time when it was so necessary to use building materials intelligently, to reduce waste, to simplify design and construction, to standardize dimensions and methods, to make parts interchangeable and fit together readily, so as to economize labor and reduce costs. If standard specifications could be prepared and agreed upon in a much larger number of cases than has yet been done it would greatly facilitate the work of architects and builders; and if building methods and the requirements of city building codes could be thoroughly studied and revised this also would aid in reducing building costs. It seems probable that hundreds of millions of dollars could be saved within a few years if a comprehensive and intelligent study were made of all phases of building, including fire prevention and the plumbing, heating, lighting and hardware equipment of buildings. It would also reduce the cost of repairs and

maintenance of these buildings; partly because deterioration would be slower and failures would be less frequent, and partly because repairs would be easier and cheaper to make. The government would do only a portion of this work of research and standardization, as many engineering societies, industrial organizations and manufacturers would cooperate. But the government should take the lead, and do an important part of the research work, and nothing which the government could do would be more useful and constructive, or would be more appreciated by the building industries and the public. Standardization work of the kind suggested has great educational value to architects, to builders, to manufacturers, to jobbers, to building owners. Is there any good reason why such a constructive program of cooperative study should not be undertaken? Can the people of this country afford to go on without it under present conditions?

STANDARDIZATION AND TESTING OF AUTOMOBILES

19. The automobile industry is one of the most important of our industries, and motor vehicles of all kinds play a most important part in the business and social life of the people. Several billions of dollars are expended each year in the purchase and maintenance of motor vehicles. Great improvements have been made in recent years in their design and construction; on the other hand, the quality of materials and workmanship has in many cases gone backward. Much progress has been made toward the standardization of the materials and parts of motor vehicles, and great credit is due to the automobile industry therefor. But there is great need for further systematic study and the preparation of specifications and tests, and the encouragement of testing so that purchasers may know better what they are buying and selling agents may describe their machines more precisely. The interests at stake are so enormous, and the possibilities of service to the public are so great, that it seems imperative that more should be done by the government to assist the industry in its great task.

GASOLINE AND MANUFACTURED GAS

20. Gasoline is getting scarcer and dearer every year, and yet not enough is being done in a systematic way to show how to economize in the use of gasoline. A thorough investigation of carburetors and fuels, and certified tests of the performance of all makes of automobiles, would be of great value in economizing in the use of gasoline, and giving the public as much service as possible for a given expenditure. The Bureau of Mines and the Bureau of Standards have studied different phases of this question, but neither has been able to do as much as should be done. With millions of automobiles in daily use, and gasoline constantly rising in price and deteriorating in quality, can the public afford to have the government fall short in a matter of so great economic importance, and of serious personal concern to so many?

Manufactured gas is used for cooking and lighting by many millions of people and by the industries for scores of uses. A large part of this gas is made by the use of petroleum oil to enrich blue water gas of low heating value. Recently this gas oil has become scarcer and dearer, and it threatens to become still more expensive and perhaps impossible to get in sufficient quantity. That will necessitate the use of lower grades of oil, or the production of lower grades of gas, or a change of manufacturing equipment at enormous expense. Individual gas companies cannot study so fundamental a question comprehensively; individual cities or states cannot assume the responsibility of solving the problem for the entire country. The proper agency to take up this question is the federal government, with the cooperation of the gas companies and the oil companies and the state and municipal authorities. Such a comprehensive and constructive study would be of great value and would have the sympathy and support of all the important interests. It should include the matter of raw materials, manufacturing methods, and the relative usefulness of the various grades of gas that can be produced.

PUBLIC UTILITIES

21. The government should cooperate actively with gas and electric and railway and telephone companies in the study of the many engineering questions involved in rendering good service to the public. The changed economic conditions of recent years have made it impossible for many public utility companies to meet expenses. In some cases they have gone into the hands of receivers, in many other cases they escape by putting up rates. But advancing the rates beyond a certain point reduces the sales and does not give a proportionate benefit. The public in the end must pay all the cost, and the public is vitally concerned in having efficient and economical management of these utilities. If the government could help the companies to help themselves, it would often be better than an increase in rates. The government could render a service of immense usefulness and importance by studying the problems of the public utilities and helping the companies to secure more efficient operation and a better understanding by the public of their difficulties and their needs. The utilities are a special kind of partnership between their owners and the public, in which the owners agree to furnish the plant and the service and the public grants a monopoly privilege and agrees to accept the service rendered and to pay the cost. If the company's credit is impaired or it fails altogether the community, as well as the company, suffers. It is evident, therefore, that the public should take a keen and intelligent interest in public utility problems, and especially in the situation which has resulted from the rising cost of labor and commodities, for which the companies are not responsible. The government has been rendering important service of this kind, enough to demonstrate its value and to show that cooperation in this work is practicable. But it could render a service of vastly greater importance to the utilities and to the public, by an expenditure, say, of one million dollars per year for research and education on utility problems. That would be only one cent per year per capita of the country's population, whereas the

value of the service that would be rendered to the public would possibly be fifty or a hundred times the cost.

STANDARDIZATION OF ELECTRICAL BATTERIES

22. One of the most productive lines of research at the Bureau of Standards recently has been a study of electrical batteries, primary and secondary. They are used in great numbers for starting and lighting automobiles, for tractors and other electric vehicles, for electrical power stations, for telephone exchanges, railway signals, door bells, flash lights and a hundred other purposes. No adequate specifications or methods of test had ever been generally agreed upon when the Bureau took up the work. They were sold without guarantee or adequate statement of performance, and the purchaser had no way of ascertaining just what he was getting. The manufacturers have cooperated cordially and intelligently in the study that has been in progress, and in time it is expected that a complete set of specifications and methods of tests will be developed. In the meantime the manufacturers have derived important benefit from the investigation and the public is getting a better product. Possibly a hundred million dollars worth of these batteries are made and sold each year, and if this work could be carried on more adequately and as thoroughly in all lines as it has already been in some lines, it seems a safe statement to make that the public would be benefited not less than five per cent on the entire product. This would amount to five million dollars per year, which is several times the cost of all the work of the Bureau of Standards, and more than a hundred times what the battery work would cost. This kind of research and educational work is like seed that falls on good ground and springs up and bears fruit, some thirty, some sixty, and some a hundred fold.

TESTING OF GOVERNMENT SUPPLIES

23. For many years electric lamps purchased by the government have been systematically inspected at the factory and samples selected for life test in the laboratory. The information so obtained is utilized in the preparation and periodical revision

of standard specifications which are used in the purchase and testing of lamps. Formerly lamps were bought by each department or government establishment separately, without specifications or tests. The prices were relatively high and the quality of the lamps often uncertain or poor. Electric lamps are made by highly specialized technical processes. It is very easy to make lamps that will give light, but difficult to make lamps of high quality. Since government purchases of lamps have been consolidated into large contracts and lamps have been tested according to proper specifications, the prices have been the lowest and the quality of the lamps the highest that the market affords. The ordering of lamps by each department is now a simple routine operation, whereas formerly the separate purchasing of lamps involved dealing with agents of various manufacturers and guessing as to who offered the best values. The systematic testing of lamps by the government not only protects the government in its purchases, but it protects the public in large measure, for the testing tends to keep up the quality of the entire product, and so benefits the public. The value of this work, which puts the purchase of lamps by the government on a business basis, and protects the manufacturer of a high-grade product as well as the user, is many times the cost of the work. The influence of the government, instead of being hurtful as it formerly was, is thus stimulating and helpful to the industry, tending to raise the quality of the product and to improve business methods.

The testing of paper for the government is another example of constructive work which puts the government's purchases on a business basis and tends to help the industry instead of degrade it. Formerly the government bought paper in great quantities on incomplete specifications with inadequate tests. Manufacturers knew that they could supply something different from what was specified, and one who was willing to do so had the advantage over one who supplied what was called for. This was an intolerable situation which was corrected when the specifications were made adequate and tests were complete and systematic.

The value of such work is incomparably greater than its cost, and it would be well if all government purchases were as intelligently and systematically handled as lamps and paper and certain other products now are. It is proposed to establish a central purchasing bureau and to have supplies purchased and delivered in wholesale quantities and tested as to quality, instead of ordering small lots separately that cannot be inspected or tested systematically. This would be a long step forward in putting the business of the government on a business basis.

TEXTILES

24. The textile industry is one of the largest and most important of our industries and one which concerns every man, woman and child in the country. If textiles were standardized, so that they could be bought and sold on adequate and intelligent specifications, and consumers as well as wholesale and retail dealers could know what they are buying and could get what they pay for, it would be of enormous benefit to all. Suppose the brand or name of every textile product was defined in such a way as to convey precise information, and the same name always meant the same quality. And suppose that dyes were tested and certified, and one could depend on the mark as to their permanence, and were told what conditions they would stand or would not stand. Would it not be worth hundreds of millions of dollars every year to the public to have such information? And would it not be a boon to honest dealers, both wholesale and retail? The only class to be injured by such a situation would be those who thrive by misrepresentation or by selling inferior goods on their appearance without representation. It seems almost certain that money intelligently spent in research and education along the lines indicated would yield results of very great value, and while it would involve some expense and trouble, it would be constructive and wealth-producing and would raise the standards of business. It seems certain that it would be as useful as the grading of lumber, or cattle, or wheat.

THE CHEMICAL INDUSTRIES

25. Rubber, leather, paints and the chemical industries generally, include a vast number of products which should be standardized and described in intelligent specifications. In many cases the product can be materially improved with little or no expense, if available information is utilized. Often it is the difficulty in securing information and not reluctance to use it that explains the poor quality. There are great numbers of small manufacturers who would avail themselves, if they could, of information to improve their product, but who cannot afford to engage in expensive research to get the information. The government could supply thousands of small manufacturers with information on hundreds of subjects if an adequate staff were made available to do the work, and this would be of direct benefit to the public which pays the cost. This is cooperative work of the most practical sort, and it has been done already in enough cases to demonstrate how productive of good results it is.

SCIENTIFIC INSTRUMENTS

26. The manufacture of scientific instruments has recently come to be an important industry in this country. This is partly owing to the greater use than formerly of scientific instruments in the industries, and partly to the war which has largely reduced the importation of scientific apparatus from abroad. An increased protective tariff is proposed to encourage and protect American manufacturers of such apparatus, but if there are no standards of excellence set up and no adequate specifications or guarantees, the purchaser will often be uncertain of what he is getting when he buys such apparatus. The government would do well to cooperate actively with the manufacturers and with scientific and engineering societies in standardizing and describing scientific apparatus, so that the manufacturer will know better the properties and capabilities of his own output of apparatus, and the purchaser will know how to select apparatus and whether he gets what he orders. In other words scientific apparatus should be scientifically described and intelligently used, and the govern-

ment could render an invaluable service in aiding to bring this about. The manufacturers of this apparatus are eager for information, and will do their part in such work. They are calling for greater service from the Bureau of Standards in instrument testing than it is able to render because of lack of men to do the work.

SAFETY RESEARCH AND THE PREPARATION OF SAFETY CODES

27. One of the most valuable opportunities for cooperative work by the government is in safety research and education; that is to say, in studying methods of reducing accidents in the industries and in every-day life, in formulating sets of safety rules or codes, and in assisting the state industrial commissions in adopting them and manufacturers in complying with them. More than 3,000,000 industrial accidents occur every year, of which 25,000 are fatal. Many millions of dollars are expended annually by employers for accident compensation, and many millions more are lost by injured employees in wages not compensated. Nearly every state has an accident commission which supervises the collection of compensation for accidents, but many of them do very little to reduce accidents. A few states have provided their commissions with generous sums to enable them to prepare safety rules and put them into effect, and valuable results have been secured by such efforts. Recently a comprehensive program of safety work has been prepared in which many agencies will cooperate. This work includes the preparation of nearly a hundred different safety codes, covering the hazards of manufacturing in many different industries, transportation, mining, and the use of electricity, gas, machinery, and explosives by the general public. These safety codes are more than mere sets of safety rules, often amounting to a standardization of engineering practice in many aspects of an industry, and being of great value in promoting efficiency and good practice as well as safety. They are prepared by the active cooperation of all the interests concerned, including engineering societies, industrial and insurance associations, state accident boards,

manufacturers of machinery and appliances, and the federal government. The work of preparing the codes involves study and discussion, a comparison of experience and a consideration of the best operating methods. Efficiency and good service are considered as prominently as safety. Some of the more important examples of these codes are the Steam Boiler Code of the American Society of Mechanical Engineers, the Electrical Fire Code of the National Fire Protection Association, the National Electrical Safety Code of the Bureau of Standards. A national elevator code, codes for steel mills, blast furnaces, foundries, machine shops, textile mills, saw mills, and dozens of other industrial establishments are being prepared or are under consideration. The government is rendering a valuable service in this work, but the work suffers for lack of funds. The industries, the engineering societies, and the state commissions are doing their share of the work. The government's share is important and should be well done. The cost of the work is trifling in comparison with its value, and it does not seem possible that this work will be allowed to lag or cease for want of funds if the general public could but understand its immense importance and usefulness. Aside from questions of humanity and the economic value of human life, the losses in wages and the damages paid in compensation amount to so many millions annually that the small amounts required for the government's share of the work are insignificant in comparison. Probably no work of the government is more useful or more productive in proportion to its cost, and none is more needed by the country at large. The states and the industries are waiting to put these safety codes into effect, and the great advantage of national uniformity will result if they are prepared so well that they can come into general use. The work should be strengthened and enlarged at an early day, as a measure of efficiency and economy as well as of humanity and good government.

METALLURGY, CERAMICS, AERONAUTICS, ETC.

28. Many other examples of the economic importance of scientific research and standardization could be cited, if time

permitted. The metallurgical industries have been greatly developed in recent years through scientific research, and there is now greater activity than ever in this field. The metallurgical division of the Bureau of Standards works in close cooperation with the engineering societies and manufacturers, and is doing work of very great industrial importance. The manufacture of glass, porcelain, tile, and other clay products has been greatly stimulated during the war by the cooperation of scientific laboratories, and vast benefit would be derived by these industries if this cooperation could be continued and even increased. The measurement of temperatures and especially high temperatures is a problem of continually increasing importance in the industries, and many scientific investigations are continually arising in this connection. The intelligent and efficient development of aeronautics depends on the possession of full and reliable information as to the properties of materials, the accurate measurement of the performance of machines, experimental researches in mechanics and aerodynamics, and the most intelligent utilization of existing and newly developed information. Considering the amount of money that is being expended in the development of aeronautics it would seem that a very considerable amount should go into scientific research. The measurement of color and of illumination and of the optical properties of materials and the development of optical methods and instruments form together a field of investigation of great scientific and economic value. It is impossible even to mention all the subjects of importance in this connection, but enough has been said to show how vast the field and how practical the results that are obtained whenever science is appealed to in answering the problems arising in the industries.

RESEARCH BY LARGE CORPORATIONS

29. The Standard Oil Company has attained a wonderful reputation for its technical and commercial success in deriving valuable products from petroleum, a result which could never have been reached without extensive scientific research.

The General Electric Company has achieved notable success in the development of electrical instruments and machinery, electric lamps, steam turbines, the applications of electricity to ship propulsion, etc., and a very large part of this success may be credited to its scientific and development work. Its research laboratories have turned out many valuable contributions to science, in addition to the results of direct application in their business. The American Telephone and Telegraph Company, and its subsidiary, the Western Electric Company, have achieved a world-wide reputation for their development of long distance telephony, multiplex telephony and telegraphy and radio telephony as well as for the development of many of the engineering features of telephone practice of the present day.

These and other great corporations carry on research work on a generous scale and derive great commercial advantage therefrom. But thousands of smaller companies cannot do what they do. The smaller companies are, however, rendering the public a service that is very essential, and the public will serve itself by helping them to improve this service. This does not mean that they will have their burdens carried for them by the government, but rather that the government as the agent of the public should participate in research and standardization work (in cooperation with manufacturers' associations and engineering societies) in order that the public may be better served and in order that the public may judge more intelligently of the quality of the product or the service rendered. It is the open door method of doing business as opposed to the method of keeping the government and the public in partial ignorance. The burden of this work when borne by over a hundred million people is very light; the benefits far outweigh the cost. The American Telephone and Telegraph Company's research laboratories employ more research workers in their single field of investigation than the Bureau of Standards does for all its many lines of work for all the industries of the country. The results obtained justify the large expense for research in the telephone field. The splendid results obtained are not due merely to the fact that work is well managed and is done by a great corporation; but

rather to the fact that abundant resources (provided of course by the public) are made available and an adequate scale of salaries is paid. Government laboratories could do as well if they had an equal or nearly equal chance; but they cannot work miracles.

THE ECONOMIC VALUE OF STANDARDIZATION

30. The American Engineering Standards Committee has recently been formed to promote engineering and industrial standardization. Five engineering societies and three departments of the government were represented initially in its membership. Several additional member societies have just been added and others will be added from time to time. The Committee is already actively at work in selecting sponsor societies for standardization work and approving standards. The government is rendering a valuable service to the industries, and thus to the people, by cooperating actively in this constructive and useful work. Manufacturers have not cooperated with one another in the past in standardizing designs as much as they could have done if there had been some practicable way of cooperating. They have resented government dictation and control, but they welcome government cooperation in constructive work that benefits both them and the public. In many cases the designs and sizes of machines and materials manufactured by different concerns are different because development has been independent. In other cases it is in order to have something upon which to base a claim of superiority. In either case, too many sizes and designs and lack of interchangeability increase the cost to the manufacturer, to the distributor and to the user. Nothing promotes economy and efficiency in the use of raw materials and finished products more than intelligent standardization. It reduces the varieties and sizes of materials that must be supplied by the manufacturer, lessens the stocks that must be carried by the distributor, makes the cost of the finished product less and reduces the trouble and expense to the user in caring for and keeping in repair machinery and equipment of all kinds. The high cost of the services of the plumber have been proverbial for years. Standardization in plumbing fixtures and fittings,

and interchangeability of parts could be carried further than it has been. This would greatly reduce the charges for time and material in making repairs as well as in the original installation. The enormous and confusing variety of lighting fixtures, and the bad design of many, are due to utter lack of standardization or cooperation of the manufacturers with one another. Inefficient and dangerous gas appliances have been sold to the public for years, and many are still in use. The manufacturers cannot be blamed, for they cannot separately engage in expensive research to arrive at correct designs. The only practicable way is for all to cooperate and for the government to take an active part, helping the manufacturers to study these problems of design and standardization intelligently and thoroughly.

THE DUTY AND OPPORTUNITY OF THE GOVERNMENT

31. Such work is constructive and wealth-producing, and yields returns a hundred-fold upon the investment. The benefit is almost immediate and not only are there material returns in decreased costs and improved service, but such cooperation between the government and the industries raises the standards of business and is helpful both to the government and to the industries. It emphasizes good quality and good performance and good service, and reduces misrepresentation and exaggeration in selling. Is it not the duty of the government to cooperate more actively in this constructive way with the industries? No other agency can perform this important function. The government would do only a part of the work, but that part is of great importance. Engineering societies, manufacturers' organizations, and individual manufacturing companies will do their part, and in many cases the greater part. But if the government refuses to do its part on the ground that it would increase taxation, the public will not be satisfied with the reason given when it knows that at the present time out of $50.00 per capita per annum collected by the government for all purposes, *scarcely more than one cent per capita per annum is expended by the government for this important work, and five cents per year per*

capita would accomplish wonders. The matter is of so fundamental importance, and promises results of so great economic and social value, that it is to be hoped that some more adequate effort along this line may be made. It seems impossible that such effort would not succeed at least in part, and even a partial success would more than repay the cost.

The English journal previously quoted says this of the government's part in scientific research: "*The endowment of research and the financing of scientific investigation are essential in any progressive nation, and if the money is well spent no amount allocated to these branches can be too great at the present stage in our country's history.*"

In Great Britain the Engineering Standards Association is largely financed by the government, while the Department of Scientific and Industrial Research is a government body financed entirely by the government. The American Engineering Standards Committee and the National Research Council (of America) are financed entirely without government aid. This is an additional reason why government research institutions in America should be so well supported that they can do their full duty in cooperation with privately supported scientific and industrial institutions which are doing work in the interest of the public.

GOVERNMENT LABORATORIES AND THEIR TRAINED PERSONNEL AVAILABLE FOR WAR

32. The war called for scientific research in connection with the standardization and making of munitions, finding and using substitute materials, locating enemy guns by sound and flash ranging, locating submarines, building and equipping ships and submarines, building and equipping airplanes, dirigibles and balloons, and many other major subjects as well as countless minor ones. This called for well-equipped scientific laboratories and the trained personnel of research workers and assistants. The government laboratories were utilized to the limit of their capacity, and all kinds of makeshift facilities were pressed into service. If preparations had been begun several years before,

it is needless to say results would have been obtained sooner and the war appreciably shortened. In view of this experience, and the probability that science and technology will be no less important in the future than in the past, the question naturally arises whether the government is making adequate preparation for scientific research as a part of its program of military preparedness? In time of war the civil branches of the government will be called upon immediately, and they will be able to render invaluable service if they are adequately equipped and manned. In the meantime, pending the arrival of the war, which we hope will never come, they will be able to render useful service in civil problems and so be more than self-supporting. This kind of preparation for war, which adds nothing to the military budget if the civil departments are adequately supported, should appeal to all as practicable and desirable.

SUMMARY OF THE ARGUMENT

33. The federal government, having emerged from participation in the World War, finds itself with a large debt and heavy annual charges caused by the war. These together with the current cost of the army and navy amount for the present fiscal year to 92.8 per cent of the total budget. The cost of public works and the necessary administrative cost of the federal government amounts to 6.2 per cent of the total. There remains one per cent for a large number of governmental activities classed as research, educational and developmental. The question arises whether in the interest of economy and efficiency the one per cent shall be decreased; or because this work is constructive and of great economic value it shall be increased, possibly doubled. The arguments in favor of increasing it may be summarized as follows:

(1) The government should be constructive and helpful to the people and to business wherever possible. It should carry on scientific research, promote education, develop the industries, assist in improving commercial and industrial methods, and furnish technical information to manufacturers and others, as

well as develop agriculture and the public domain. Such service by the government tends to establish good relations with business, to elevate business methods, to increase efficiency and to educate the public. The many services thus rendered cost very little in the aggregate as compared with the total expense of the government, but they are of great practical value and are appreciated by the people. *One per cent of the total expenses of the government spent in this constructive way seems a very small proportion in view of the wide range and the economic value of such work.*

(2) But a part of this one per cent is incurred in behalf of the government itself, to enable the government to purchase its supplies intelligently and to do business in a businesslike way. Without this research and testing work the government would waste more in buying than it would save by eliminating the research and testing. Making purchases without full technical information is embarrassing to public officials and unsatisfactory to business; whereas by always using intelligently drawn specifications and making adequate tests, the government can save money, elevate its own service and improve business methods. Much but not enough of this kind of work is now done. It is the duty of the government to set a good example before the business world of efficient and intelligent methods and fair dealing; neither accepting goods below the specified quality nor demanding more than is specified. *The government would spend less for its purchases if it spent more in standardizing the products purchased and in testing deliveries systematically.*

(3) But apart from the service the government can render its citizens, and the benefit to the state resulting from scientific, educational, and developmental work, and apart from the benefit to the government of having the results of such work in constructing buildings and other public works, and carrying on its business, this kind of work develops wealth, and the increased wealth can be taxed, and hence there is a third reason for increasing such work. The war has made it necessary to raise many times the revenue formerly required, and the taxation is now an important issue. Economizing in the use of raw materials, using

cheaper materials, reducing waste, developing the public domain, increasing manufacturing efficiency, reducing distribution costs, all tend to create wealth and to make it easier for the government to raise the needed revenue. Therefore, if there were no other reason, this consideration should appeal to legislators and business men alike; *namely, that research and development work by the government develop wealth, and the burden of taxation is thereby lightened.*

(4) But there is another powerful economic reason for increasing the productive developmental work of the government. The rising cost of living not only leads to hardship and distress, but to industrial unrest, strikes, disorders and great economic losses to the nation. In order to check rising prices, and if possible bring down prices, it will be necessary to increase production. To do this it is necessary to reduce waste and increase efficiency. This requires greater intelligence and fuller knowledge, and calls for education, the results of scientific investigation and of intelligent and extensive industrial research. The government could not and should not do it all. But neither should it refuse to do its part, and its part often is to take the lead in a constructive and statesmanlike way. It is stupid and blind to think that because taxes are heavy we cannot afford to do things intelligently. If a farmer's barn burns down, he would not sell half his supply of seed and fertilizer to buy lumber, and then plant only half a crop. He would, if necessary, borrow money to buy more seed and plant a larger crop than usual, in order to increase his income and pay for the new barn more easily. *Intelligent research by the government, in cooperation with the industries, is like seed and fertilizer to a farmer. It stimulates production and increases wealth, and pays for itself many-fold. It is as productive and profitable in peace as in war.*

(5) Finally, if the reasons already adduced are not sufficient, there remains the military reason. The development of our intellectual, moral, and material resources is the best preparation for war. Food and manufacturing facilities, and adequate supplies of raw materials and transportation systems and scientific attainments and the equipment and trained personnel

available for military research, these together with an intelligent citizenry and a just cause are the best preparation for war. A standing army and fleets of battleships are necessary but not a sufficient preparation, even if the army is armed to the teeth and the battleships are the heaviest or the swiftest in the world. The Great War demonstrated that modern wars are not of armies but of peoples, and their resources and their intellectual and industrial resourcefulness are more important than the initial equipment of armies and fleets. Therefore, a government that pays much attention to education and research and industrial developmental work is making the best preparation for possible wars of the future. *This fortunately produces good results if war never comes. By increasing the power and prestige of the nation, such preparation tends to prevent war, and so pays for itself twice over.*

CONCLUSION

34. Probably everyone will grant the principle that a government should do something to educate the people, and to develop the industries and the natural resources of the country. It is only a question of the scope and extent of such work. The government has already done much, but in comparison with the needs and the opportunity it is inadequate. Cooperation of all the people in developing themselves and improving their condition and securing protection against the selfish and unfair efforts of individuals or corporations or groups, is more necessary in the modern state than formerly. And when the state contains a hundred million people and covers a continent, effective cooperation in many cases can be attained only by government assistance and leadership. Friendly governmental cooperation and constructive assistance in the industries are more welcome than regulation and repression. We must have the latter in some cases, and that is an additional reason why we should have a generous measure of the former. How far we should go experience alone can determine. But we should have the courage to face the facts, to analyze them correctly and, both in the government and in the nation, *to do as well as we know how.* We should

strive for a higher and truer efficiency, for efficiency in the government, efficiency in labor, efficiency in business; and the government should not fail to do its part, which in many cases is to take the lead. If the government will cooperate with the industries in peace as earnestly and effectively as the industries cooperated with the government in war, it would be of vast benefit to the public, which pays all the costs.

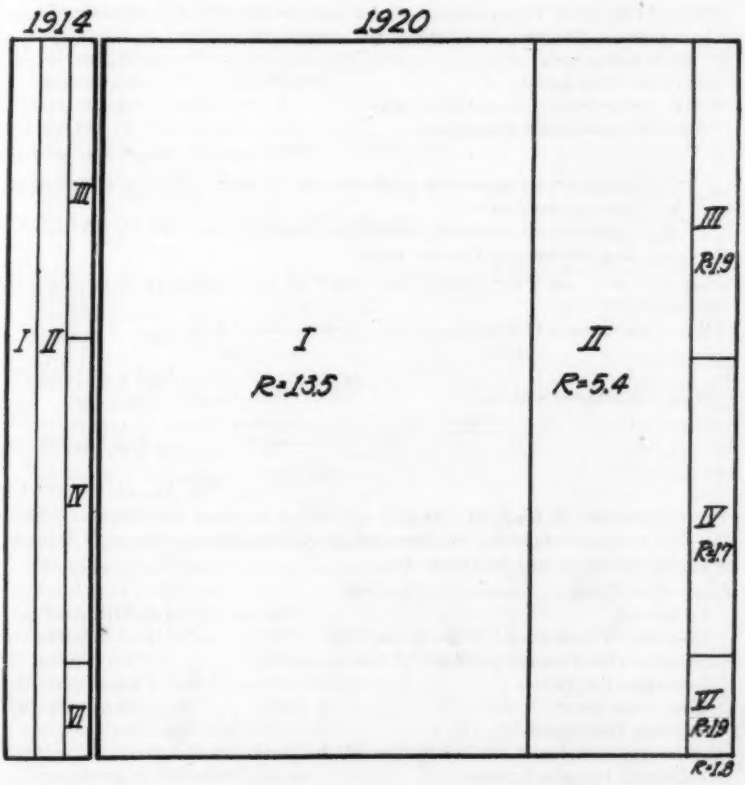

Fig. 3.—Diagrammatic comparison by groups of appropriations for the fiscal years 1914 and 1920.

APPROPRIATIONS FOR FISCAL YEAR ENDING JUNE 30, 1920

(As given in the regular supply bills and three deficiency bills prior to May 1, 1920.)

Group I.—Expenditures Arising from Recent and Previous Wars:

Interest on the Public Debt[a]	$1,076,637,000.00
Pensions	216,382,540.00
War Risk Insurance (estimated expenses above receipts $102,000,000)	120,852,806.00
Federal Board for Vocational Education (rehabilitation)	30,000,000.00
Public Health Service (care of soldiers, etc.)	25,901,517.14
Soldiers' and Sailors' Homes, Cemeteries, etc.	14,639,010.00
Federal Control of Transportation (deficit and advances)[b]	1,550,000,000.00
United States Shipping Board (estimated expenses, including funds reappropriated)	685,842,000.00
European Food Relief	100,000,000.00
Other Expenditures due to Recent War	4,467,712.46
Bonus to Government Employees	30,760,000.00
67.81%,	$3,855,482,585.60

[a] Disbursements for interest on public debt for the fiscal year 1920 will be somewhat less than appropriations.

[b] Appropriations to Railroads include $300,000,000 loan, but do not include the deficit from March 1 to June 30, 1920.

Group II.—War and Navy Departments (somewhat above permanent peace-time expenditures):[a]

War Department—Military	$797,913,898.95	
Civilian	6,373,949.12	
		$ 804,287,848.07
Navy Department—Military	617,621,353.56	
Civilian	2,229,474.94	
		619,850,828.50
25.02%,		$1,424,138,676.57

[a] Disbursements for fiscal year 1920 will exceed by about one billion of dollars the above appropriations for the War and Navy Departments because of balance of appropriations carried over from 1919.

Group III.—Primary Governmental Functions:

Legislative		$ 10,837,936.47
Executive (President and White House Staff)		324,080.00
Judicial (federal courts, penal establishments, etc.)		12,124,884.24
Department of Justice		4,483,671.70
State Department		12,331,371.97
Treasury Department:		
General, including Collection of Customs	$ 29,065,653.22	
Internal Revenue Service	29,751,170.00	
Coast Guard	8,880,523.33	
Bureau of Engraving and Printing	7,010,425.00	
		74,707,771.55

Department of Interior:		
General, including Alaskan Expenditures	$ 1,940,684.92	
Indian Office and Indian Service	11,437,187.00	
		$ 13,377,871.92
Department of Commerce:		
General, including Bureau of Navigation	920,725.52	
Bureau of Lighthouses	8,411,030.00	
Steamboat Inspection Service	995,890.00	
Bureau of Census	17,550,000.00	
		27,877,645.52
Department of Agriculture:		
Meat Inspection Service		3,000,000.00
Department of Labor—Immigration, Naturalization, Employees' Compensation, Conciliation, etc		5,464,337.32
Interestate Commerce Commission		5,313,086.90
Federal Trade Commission		1,205,000.00
Civil Service Commission		543,700.00
Joint Commission on Reclassification of Salaries		50,000.00
U. S. Tariff Commission		300,000.00
Bureau of Efficiency		145,000.00
One-half District of Columbia, Hospitals, etc		9,100,867.82
	3.19%,	$ 181,087,225.41
Group IV.—Public Works:		
War Department—Rivers and Harbors		$ 43,456,653.15
Treasury Department—Public Buildings (equipment and construction)		10,319,076.11
Repairs and Maintenance of Public Buildings in D. C.		1,139,633.20
U. S. Reclamation Service		7,511,000.00
Department of Agriculture—Rural Post Roads		99,000,000.00
National Park Service		777,195.00
Construction of Railroad in Alaska		6,000,000.00
	2.97%,	$ 168,203,557.46
Group V.—Commercial or Self-Supporting Government Activities:		
Post Office Department, surplus, 1919	$ 2,342,851.96	
Department of Interior:		
Patent Office, surplus, 1919	106,654.10	
General Land Office, estimated surplus, 1920	1,500,000.00	
U. S. Housing Corporation, estimated operating surplus, 1920	1,012,973.00	
Panama Canal, estimated deficit, 1920	3,297,337.00	
Group VI.—Research, Educational and Developmental:		
Department of Agriculture:		
Forest Service—Less Receipts of $4,750,000.00	$ 4,191,869.00	
Bureau of Animal Industry	5,783,231.00	
States Relations Service	4,905,820.00	

Bureau of Plant Industry	$ 3,379,638.00	
Cooperative Agricultural Extension Work	3,080,000.00	
Markets	2,811,365.00	
Weather Bureau	1,880,210.00	
Bureau of Entomology	1,371,360.00	
Bureau of Chemistry	1,391,571.00	
Bureau of Biological Survey	742,170.00	
Bureau of Public Roads	594,320.00	
Bureau of Soils	491,235.00	
Bureau of Crop Estimates	372,484.56	
Bureau of Farm Management and Farm Economics	302,590.00	
Horticultural and Insecticide Board	252,940.00	
Miscellaneous Investigations	2,389,400.00	
General Administration	1,715,626.58	
		$ 35,855,830.14
Department of the Interior:		
Geological Survey	1,661,353.50	
Bureau of Mines	1,216,897.00	
Bureau of Education	241,960.00	
Howard University	121,937.75	
		3,242,148.25
Department of Commerce:		
Coast and Geodetic Survey	1,925,370.03	
Bureau of Standards	1,892,260.00	
Bureau of Fisheries	1,274,490.00	
Bureau of Foreign and Domestic Commerce	912,510.00	
		6,004,630.00
Department of Labor:		
Bureau of Labor Statistics	321,690.00	
Children's and Women's Bureaus	320,140.00	
		641,830.00
Treasury Department—Public Health Service		4,025,440.00
Federal Board for Vocational Education		3,182,000.00
Colleges for Agricultural and Mechanic Arts		2,500,000.00
Library of Congress		925,825.00
Smithsonian Institution		715,957.51
	1.01%,	$ 57,093,660.93

SUMMARY

Group I.	Expenditures arising from Recent and Previous Wars	$3,855,482,585.60	67.81%
Group II.	War and Navy Departments	1,424,138,676.57	25.02%
Group III.	Primary Government Functions	181,087,225.41	3.19%
Group IV.	Public Works	168,203,557.46	2.97%
Group VI.	Research, Educational and Developmental	57,093,660.93	1.01%
	Total	$5,686,005,705.97	100.00%

SCIENTIFIC NOTES AND NEWS

THE MEYER MEMORIAL MEDAL

FRANK N. MEYER was an agricultural explorer in the Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, U. S. Department of Agriculture. For thirteen years he searched through China, Turkestan and other parts of Asia, for plants which might be valued additions to American agriculture and horticulture. When he lost his life on the Yangtze River in 1918,[1] he left a bequest of a thousand dollars to the staff of the Washington Office. The individuals of the Office have put the bequest into a permanent tribute to his memory, in the shape of a medal, designed by Theodore Spicer-Simson, which is to be awarded for distinctive service in plant introduction. The awards are to be made by the Council of the American Genetic Association.

The first award was made on May 3, 1920, when the medal was presented to Mr. BARBOUR LATHROP. Dr. DAVID FAIRCHILD, in behalf of the Council, presented the medal. Mr. Lathrop had a large part in the founding of the Office of Foreign Seed and Plant Introduction, and has been intimately connected with it since. He and Dr. Fairchild comprised one of the first exploration expeditions, and visited the West Indies, South America, Europe, Egypt, India, Ceylon and the East Indies. Many introductions now growing in this country were secured on this and subsequent trips which Mr. Lathrop conducted and financed. The first seed of the Egyptian cotton, the culture of which now amounts to $20,000,000 a year in Arizona, was brought in by them. The tropical mangos, now an industry in Florida; the Persian Gulf dates, peculiarly successful in the Imperial Valley; Sumatra wrapper tobacco, now famous in Connecticut; the first large collection of Japanese flowering cherries; Rhodes grass, which has been called the timothy of the South; and varieties of soy beans and the oriental timber and edible bamboos of Japan, which are now represented by groves in various parts of the South, were also secured.

NOTES

With a view to determining the exact routes followed by migratory birds, their speed of travel, the causes of unusual movements by such birds, and many other questions of interest to naturalists as well as to the public, the Bureau of Biological Survey, U. S. Department of Agriculture, has taken over the work heretofore carried on by the American Bird Banding Association, which has headquarters at the American Museum of Natural History, New York City. This work includes the trapping of birds and the placing of identification bands on their legs, after which the birds are released. Subsequent discovery of these bands on trapped or dead birds is reported by the finders to those in charge of the work. The Biological Survey asks the coopera-

[1] See This JOURNAL, **8**: 463. 1918. **9**: 559. 1919.

tion of all former members of the Bird Banding Association and the public in general, particularly persons in a position to establish trapping stations. Arrangements are being made to supply volunteer cooperators with numbered aluminum bands.

Dr. N. E. DORSEY, physicist in charge of investigations of radioactive substances at the Bureau of Standards, resigned from the Bureau in April. He expects to complete his work at the Bureau by the end of June, and will then go into private consulting and testing work. He will give especial attention to those physical problems that are of interest to members of the medical profession.

Mr. E. D. GORDON of the Weights and Measures Division, Bureau of Standards, resigned on May 31 to accept a position as sales engineer with the General Automatic Scale Company of St. Louis.

Mr. C. H. KIDWELL, Chief of the Water Resources Laboratory, U. S. Geological Survey, resigned in May to accept a position with the Solvay Process Company at Syracuse, New York.

Dr. F. KÖLPIN RAVN, of Denmark, visited the Bureau of Plant Industry in May. He was in the United States in the interests of Danish potato growers, as considerable quantities of potatoes are being shipped from Denmark and have to pass certain inspection regulations before being permitted to enter the country. Dr. Ravn, when in the United States in 1915 as a guest of the Department of Agriculture, discovered the stripe rust of wheat in Arizona and later in other western States.[1]

Mr. CEPHAS HEMPSTONE SINCLAIR, hydrographic and geodetic engineer in the U. S. Coast and Geodetic Survey, died on May 16, 1920, in his seventy-third year. Mr. Sinclair was born at Charlottesville, Virginia, December 4, 1847. After graduating from the University of Virginia he entered the Coast and Geodetic Survey as an aid in 1873, and had been in the service since that date. For a number of years, ending in 1913, he was in charge of a party engaged in the survey of the boundary between the United States and Canada. He was a member of the ACADEMY, the Philosophical Society, and the Society of Engineers.

Dr. ALEXANDER WETMORE of the Biological Survey, U. S. Department of Agriculture, has gone to Buenos Aires in connection with an investigation into the status of certain of our migratory birds that pass a part of the year in southern South America. Extended field observations to determine local conditions affecting these birds, covering approximately a year, will be made in Argentina and adjacent countries.

[1] After this item went to press word was received that Dr. Ravn died on May 24, at East Orange, New Jersey.